# METHOD FOR IMPROVING POSITIONED ACCURACY FOR A DETERMINED TOUCH INPUT

## FIELD OF THE INVENTION

[0001] The present invention is directed generally to a touch sensor, and more particularly to a method and system for determining the location of a touch on a touch screen.

## BACKGROUND

[0002] A touch screen offers a simple, intuitive interface to a computer or other data processing device. Rather than using a keyboard to type in data, a user can transfer information through a touch screen by touching an icon or by writing or drawing on a screen. Touch screens are used in a variety of information processing applications. Transparent touch screens are particularly useful for applications such as cell phones, personal data assistants (PDAs), and handheld or laptop computers.

[0003] Various methods have been used to determine touch location, including capacitive, resistive, acoustic and infrared techniques. Touch location may also be determined by sensing the force of the touch through force sensors coupled to a touch surface. Touch screens that operate by sensing touch force have several advantages over other technologies mentioned above. First, force sensors do not require the touch surface to be composed of special materials that may inhibit optical transmission through the touch surface, as in a resistive touch sensor. Further, force sensors do not rely on a lossy electrical connection to ground, as is required by a capacitive touch screen, and can be operated by a finger touch, gloved hand, fingernail or other nonconductive touch instrument. Unlike surface acoustic wave technology, force sensors are relatively immune to accumulations of dirt, dust, or liquids on the touch surface. Finally, a force sensor is less likely to detect a close encounter with the touch surface as an actual touch, which is a common problem with infrared touch screens.

[0004] Force based touch screens are potentially prone to errors in reported touch location from a number of sources. A force responsive touch signal produced by touch screen force sensors may be affected by a variety of static and dynamic factors in addition to the touch force. These factors may be considered noise sources with respect to the touch signal. Noise may be introduced through the touch screen electronics, or it may be mechanical in nature. Electrical noise may be introduced, for example, in the touch sensing, amplification, data conversion or signal processing stages. Mechanical noise may arise from torsion of the touch screen, movement of the touch screen device, vibration of the touch screen, and other transient factors. The touch screen force sensors may be affected by the weight of the touch surface and preloading forces applied to the force sensors during manufacture. In addition, noise may be introduced by the touch itself.

[0005] The touch force typically changes rapidly throughout the duration of a touch. A touch in a single location produces a touch force signal that increases in magnitude as the touch is applied and then decreases in magnitude as the touch is removed. The touch may also be moved across the surface of the touch screen, generating a changing signal at each force sensor. Accurate determination of the touch location requires analysis of touch force signals generated by the touch force, as well as elimination of the static and dynamic noise signals affecting the touch screen.

## SUMMARY OF THE INVENTION

[0006] In general terms, the present invention relates to a method and system for detecting the location of a touch on a touch sensor. Features of the present invention are particularly useful when combined with a microprocessor-based system operating a display device enhanced by a transparent touch screen.

[0007] In accordance with one embodiment of the present invention, a method for determining a touch location on a touch screen involves acquiring a touch signal corresponding to a touch on the touch screen, detecting a first occurrence of a touch signal shape in the touch signal, and determining touch location using touch signal information obtained in response to detecting the touch signal shape.

[0008] Another embodiment of the present invention includes associating a touch signal shape with a level of touch signal error. A touch signal corresponding to a touch on the touch screen is acquired. A first occurrence of the touch signal shape in the touch signal is detected. The touch location is determined using touch signal information obtained in response to detecting the touch signal shape.

[0009] A further embodiment of the invention involves associating a touch signal shape with a local minimum in touch-induced error present in the touch signal. A touch signal is acquired and a particular time at which the touch signal shape is present in the touch signal is determined. The touch location is determined using touch signal information obtained at the particular time.

[0010] In accordance with another embodiment of the invention, a method for determining a touch location on a touch screen includes acquiring a touch signal arising from a touch force on a touch screen and detecting a touch signal shape within an interval of the touch signal associated with maximum touch force. The touch location is determined using touch signal information obtained in response to detecting the touch signal shape. Another approach of the present invention includes acquiring a touch signal representative of a touch on the touch screen, the touch signal having an error related to the rate of change of the touch signal. A particular time is detected for obtaining touch signal information to determine touch location based on the rate of change of the touch signal. Touch location is determined using the touch signal information obtained at the particular time.

[0011] Another embodiment of the invention, a touch screen system includes a touch surface and a plurality of touch sensors physically coupled to the touch surface. Each of the touch sensors produces a sensor signal in response to a touch applied to the touch surface. A control system, coupled to the touch sensors, receives sensor signals and acquires a touch signal from the sensor signals corresponding to a touch on the touch screen, detects a first occurrence of a touch signal shape in the touch signal, and determines touch location using touch signal information obtained in response to detecting the touch signal shape.

[0012] Another embodiment of the invention is directed to a touch screen display system. In this embodiment, a touch screen display system includes a touch surface and a plu-